

**RHYSOPHORA LAFFOONI, NEW SPECIES (DIPTERA: EPHYDRIDAE), A
SAPROPHAGE ON WATER LETTUCE (*PISTIA STRATIOTES* L.) IN FLORIDA**

D. L. DEONIER

P.O. Box 405, Lawrence, KS 66044, U.S.A.

Abstract.—In a holistic approach, the adult and immature instars of *Rhysophora laffooni* Deonier, new species, are described and illustrated. This species was found in specific association with *Pistia stratiotes* L., or water lettuce, from southern Florida as far north as Polk County. The larvae were found to feed on decay microbes (microsaprophagous), but not on healthy, or undamaged, plant tissue. The basis for this specific plant association and other aspects of the life history and ecology are discussed.

Key Words: *Rhysophora, laffooni, Pistia*, water lettuce, immature stages, ecology

Rhysophora was described by Cresson (1924) as a monotypic genus based on *R. robusta* Cresson. Mathis (1977) revised the genus and added two new species, *R. liropus* Mathis and *R. ardeoceras* Mathis. Rao and Mathis (1995), in the most recent revision of the genus, added the species *R. griseola* Rao and Mathis. Mathis and Zatzwarnicki (1995), in their world catalog, placed *Rhysophora* in the tribe Discomyzini, one of two tribes in the subfamily Discomyzinae (one of five subfamilies recognized in the family Ephydriidae). Through the efforts of Cresson (1924, 1942, and 1946), Mathis (1977), and Rao and Mathis (1995), *Rhysophora* can be differentiated from other ephydrid genera by the following combination of characters: inner vertical macrochaeta much longer than outer vertical (at least $1.3 \times$ as long in known species); 2-3 fronto-orbital setae, with 1-2 proclinate (antero-clinate) and 1 reclinate (postero-clinate); intrafrontal setae absent; 8-15 dorsal arisal rays; mesonotal discal setae generally small and uniordinal except for pair of prescutellar macrochaetae (displaced dorsocentrals *vide* Rao and Mathis 1995) and sometimes last pair of acrosti-

chals; supra-alars macrochaetous; wing membrane hyaline to slightly fumose; wing vein R_{2+3} nonsetulose basad of crossvein $r-m$; alula usually well developed but relatively narrow; male metabasitarsomere slightly swollen, with row of pale semi-helicoid (torqued) setulae or setae in ventral groove.

Rhysophora robusta Cresson is distributed within the Nearctic from Ontario, Quebec, Maine, Michigan, Ohio and southward along the Atlantic coast to Florida and Texas. The adults are nectarophagous on and the larvae bore in the (mostly unopened) florets of *Pontederia cordata* L. (Deonier, unpublished data). *Rhysophora liropus* Mathis is known only from Buenos Aires Province of Argentina, where it was reared from *Pontederia* sp. and collected as puparia from *Pontederia* sp. and *Eichhornia azurea* (Sw.) Kunth. *Rhysophora ardeoceras* Mathis occurs from Mexico southward through El Salvador and Costa Rica to Colombia and Surinam, and *R. griseola* Rao and Mathis from Mexico southward through Costa Rica to Venezuela and Ecuador.

The purpose of this study is to describe

holistically (i.e. the entire life cycle of) *Rhysophora laffooni* Deonier, new species, and to provide data and other information on its life history and ecology.

METHODS

The methods used in this study are the same as those in Deonier (1993). Drawings were made on graph paper with an ocular grid fitted in stereoscopic dissecting and compound microscopes. All scales on drawings are in parts of 1 mm. Specimens for the scanning electron micrographs were prepared by placing them in a critical point dryer before sputter coating them with gold.

The descriptive terminology follows that in McAlpine (1981) and in Rao and Mathis (1995), with the exceptions noted below. The adult description is based on 5 male and 5 female specimens (for some characters as many as 15 specimens). Frequently used measurements, ratios, and indices are defined as follows: *Body length* = Distance between the most prominent part of the face and the posterior end of the abdomen, measured in lateral view and as if head and abdomen were aligned horizontally. *Color* = Descriptions of color apply to views perpendicular to the sclerite concerned unless otherwise stated. Color designations are according to the ISCC-NBS method. *Frons width-to-length ratio* = The frontal width measured at the level of the anterior ocellus divided by the frontal length measured from the anterior margin of the frons to the posterior margin of the posterior ocelli. *Face width-to-height ratio* = The narrowest width between the eyes divided by the height measured vertically from the epistoma to the ptilinal suture (inverse of mesofacial index of Deonier 1971, etc.). *Gena-to-eye ratio* = The genal height measured at the maximum eye height divided by the maximum eye height (inverse of ocular index of Deonier 1971, etc.). *Eye width-to-height ratio* = The eye width divided by the eye height, with both measurements being the greatest distances taken with the eye viewed laterally. *Costal-vein ratio* = The

straight-line distance between the apices of R_{2+3} and R_{4+5} divided by the distance between the apices of R_1 and R_{2+3} . *M-vein ratio* = The straight-line distance along M between crossveins dm-cu and r-m divided by the distance apicad of crossvein dm-cu (inverse of M_{1+2} index of Deonier 1971, etc.). *Subcranial index* = The quotient of the subcranial width, or breadth, divided by the width of the anteclypeus (clypeus of some authors).

Depositories for the type material are the National Museum of Natural History, Smithsonian Institution (USNM) for the holotype and many paratypes, the Florida State Collection of Arthropods (FSCA), California Academy of Sciences (CAS), and the Deonier Collection (DLD) for the remaining paratypes.

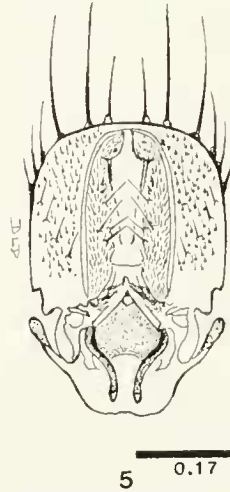
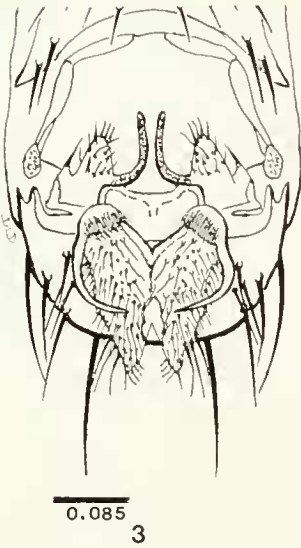
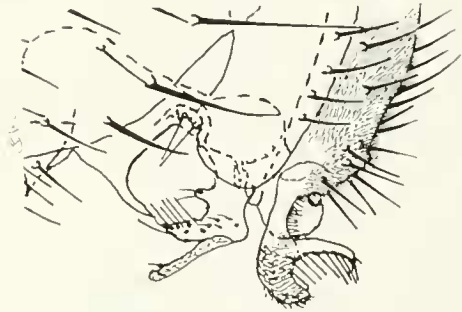
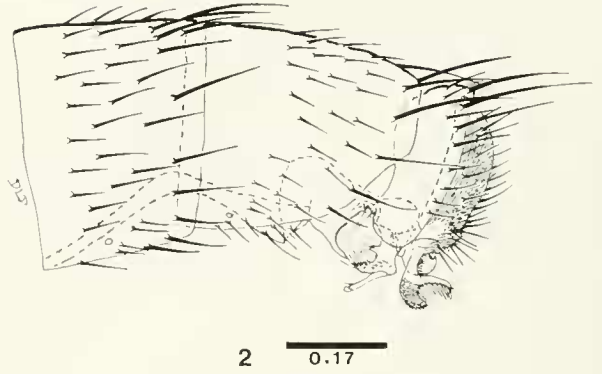
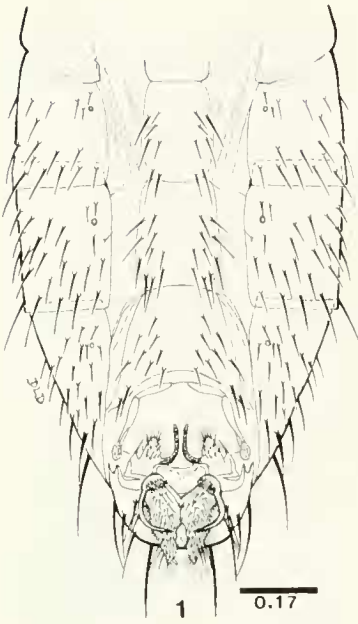
Rhysophora laffooni Deonier, new species (Figs. 1–28)

Diagnosis.—Frons width-to-length ratio 0.47–0.60; postocellar setae absent (0 setae immediately posterior to ocellar triangle); inner vertical macrochaeta inserted about width of palpus from outer vertical and 2.5–3.0 × as long as outer vertical; inner vertical curving posteriad and among longest of body macrochaetae (subequal to head height and to apical scutellar macrochaeta); 2 fronto-orbital macrochaetae: 1 anterior anteroclinate (proclinate) 0.3–0.5 as long as posterior reclinate (posteroclinate) macrochaeta and 1 small setula inserted lateral to posterior fronto-orbital macrochaeta; antennomere 3 (flagellomere 1) noticeably longer than combined length of 1 and 2, bluntly rounded apically and not noticeably tapered; face width-to-height ratio 0.54–0.64; face, in profile, nearly vertical and only slightly convex; facial carina absent; 2 medioclinate (not cruciate) primary facial macrochaetae and 2 smaller ventral setulae (all on lower 0.3 of face); eye-width-to-height ratio 0.66–0.82; gena-to-eye ratio 0.13–0.16; maxillary palpus curved, spatulate, dark grayish-brown or black and with 3–5

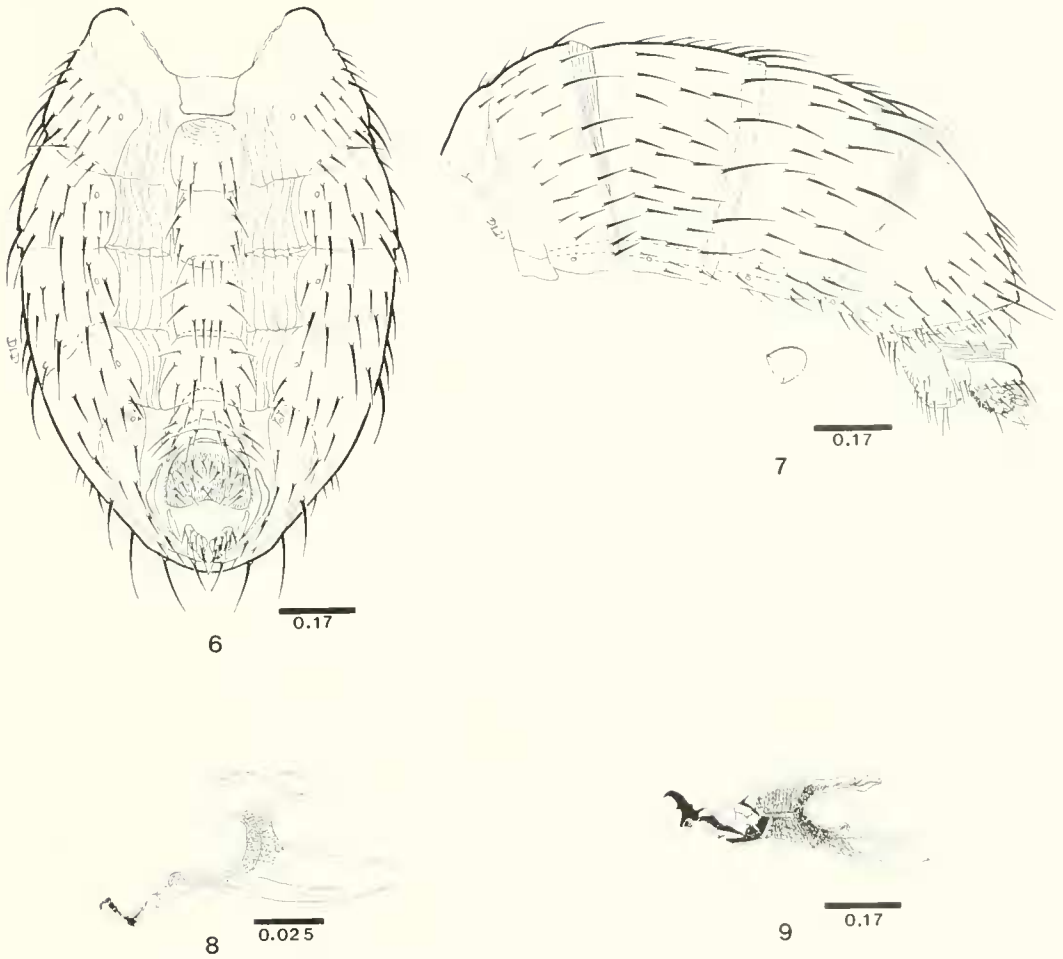
setae (including 1 long, black preapical seta 0.3–0.5 as long as palpus). Anterior notopleural macrochaeta usually 1.3–1.6 \times length of posterior macrochaeta and inserted at 0.3–0.5 (usually at 0.5) length of notopleural suture from its anterior end; 1 mesokatepisternal macrochaeta and 6–8 setulae mostly in vertical row just anterior to macrochaeta; legs dark brown except lighter brown coxae and trochanters and mostly moderate yellow meso- and metatarsi; male metabasitarsomere slightly expanded and bearing ventral row of pale semihelicoid setulae; costal-vein ratio 0.60–0.73; M-vein ratio 0.60–0.70. Male abdominal apex (dorsum of epandrium) and margin of tergum 5 each bearing 2–3 pairs of long macrochaetae; surstylus, in lateral view, somewhat falciform, but with medially curving, long, spicate process bearing ventral comb of 10 or more long, fine setulae; distal lobe of surstylus with dense covering of uniformly directed micropubesence. No male sternum with central or medial membranous area; sternum 5 about 1.7 \times as wide as 4. Female cercus, in lateral view, obovoid, about 1.6 \times as long as wide (shorter than sternum 8 and slightly longer than tergum 8); sternum 8, in ventral view, with slightly concave posteromedial margin, about 0.8 as wide as sternum 5 and subequal to or slightly wider than other sterna. Male length 1.94–2.82 mm; female 2.00–3.30 mm. Male postabdomen as in Figs. 1–5, 10; female abdomen and postabdomen as in Figs. 6–7.

Description.—*Head*: Frons width-to-length ratio 0.47–0.60; mesofrons (frontal vitta), in anterior view, semiglossy to glossy dark grayish brown; parafrons (parafrontalia) velvety dark brown or black; fronto-orbital area with sparse light-gray or light-brown pruinosity (microtomentum of Rao and Mathis 1995); postocellar setae absent (0 setae immediately posterior to ocellar triangle); inner vertical macrochaeta inserted about width of palpus from outer vertical and 2.5–3.0 \times as long as outer vertical; inner vertical curving posteriad and among

longest of body macrochaetae (subequal to head height and to apical scutellar macrochaeta); 2 fronto-orbital macrochaetae: 1 anterior anteroclinate (proclinate) 0.3–0.5 as long as posterior posteroclinate (reclinate) macrochaeta and 1 small setula inserted lateral to posterior fronto-orbital macrochaeta. Scape (antennomere 1) dark brown or black; pedicel (antennomere 2) dark brown or black with 2 dorsoapical spinoid setae, each about as long as width of antennomere 3; 1 anteroclinate and 1 latero-clinate just posterior with a cluster of 4 setulae near it; 9–12 (usually 10) dorsal arisal rays with longest ray 1.5–2.0 \times as long as greatest width of antennomere 3 (flagellomere 1); antennomere 3 noticeably longer than combined length of 1 and 2, bluntly rounded apically and not noticeably tapered, dark brown dorsally with remainder usually light brown and conspicuously micropubescent distally. Face width-to-height ratio 0.54–0.64; face, in profile, nearly vertical and only slightly convex; antennal foveae only slightly apparent on either side of slight central facial elevation (facial carina absent); epistoma shallowly to moderately concave in anterior view; face usually densely light-gray pruinose; lunule usually light gray, but occasionally light-brown pruinose; parafaciale very light yellowish gray (beige) and flaring very gradually ventrad to light-gray or light-brown pruinose gena; 2 medioclinate (not cruciate) primary facial macrochaetae and 2 smaller ventral setulae (all on lower 0.3 of face); 4–5 secondary facial setulae very near upper or central part of parafaciale; 1 genal macrochaeta slightly longer than anterior fronto-orbital and cluster of about 3 setulae just posterior to it; 16–24 postocular setae nearest orbit; eye width-to-height ratio 0.66–0.82; gena-to-eye ratio 0.13–0.16; subcranial index 1.4–2.2; anteclypeus semiglossy dark brown with very slight light-gray pruinosity; maxillary palpus curved, spatulate, dark grayish brown or black, but usually partly infuscated ventrally and with 3–5 setae (including 1 long, black preapical seta



Figs. 1-5. *Rhysophora laffooni*. 1, Male abdomen, ventral view. 2, Male postabdomen, left lateral view. 3, Male postabdomen, enlarged ventral view. 4, Male postabdomen, enlarged left lateral view. 5, Male postabdomen, posteroventral view.



Figs. 6–9. *Rhyssophora laffooni*. 6, Female abdomen, ventral view; 7, Female abdomen, left lateral view; 8, Larval feeding apparatus (mouth-hooks + cephalopharyngeal skeleton), first instar, left lateral view; 9, Larval feeding apparatus (mouth-hooks + cephalopharyngeal skeleton), third instar, left lateral view.

0.3–0.5 as long as palpus); prementum dark reddish brown with 2 pairs of distal setulae.

Thorax: Postpronotum dark grayish brown with very slight light-gray pruinosity in dorsolateral view; mesonotum, in dorsolateral view, semiglossy dark grayish brown with slight light-gray or light-brownish pruinosity; notopleuron mostly glossy to semiglossy dark grayish brown (nearly black) in dorsolateral view, but occasionally showing slight light-grayish or light-brownish pruinosity and with anterior notopleural macrochaeta usually $1.3\text{--}1.6 \times$ length of posterior macrochaeta and inserted at 0.3–

0.5 (usually at 0.5) of length of notopleural suture from its anterior end; notopleuron often with 1 anterodorsal setula near or in anterodorsal notopleural impression; mesoscutum with dorsocentral and acrostichal setae all small (setulous) and subequal; mesoscutal macrochaetae (*vide* Osten Sacken 1881) restricted to: 1 sublateral (dorsal to anterior notopleural), 1 supra-alar (subequal to basal scutellar), 1 postalar (about 0.8 as long as basal scutellar), 2 interalars (posterior subequal to apical scutellar and $4 \times$ as long as anterior), and 1 prescutellar (set between acrostichal and dorsocentral

rows just anterior to mesoscutellum) 0.6–0.8 as long as basal scutellar macrochaeta; mesoscutellum colored as mesoscutum except slightly more pruinose in dorsolateral view and with sparse discal setulosity (usually 8–12 setulae). Pleuron mostly with slight light-gray or light-brown pruinosity over dark grayish brown or black except glossy or semiglossy on anterior 0.5 of mesanepisternum and mesokatepisternum; 1 large mesanepisternal macrochaeta subequal to prescutellar (and 2 smaller: 1 about 0.5 size of largest and another about 0.2 size of macrochaeta) near mesopleural suture; 1 mesokatepisternal macrochaeta and 6–8 setulae mostly in vertical row just anterior to macrochaeta; 2 basal coxal setae (1 macrochaetous). Legs dark brown with areas of sparse light-gray or light-brown pruinosity except coxae and trochanters mostly light brown (procoxa with light-gray or light-brown pruinosity) and mostly moderate yellow meso- and metatarsi (these with distal 1–2 tarsomeres dark brown in both sexes, but in addition with metabasitarsomere moderate to dark brown in male); male metabasitarsomere slightly expanded and bearing ventral row of pale semihelical setulae; profemur with posteroventral row of 8–10 fine, nearly uniform setae; mesofemur with anteroventral row of 10–12 short setae and 2 anteromedial rows of about 10 somewhat irregular setae, including 1 macrochaeta subequal to anterior notopleural inserted at about 0.6 distance from trochanter to femur apex in lower of 2 rows. Wing length 2.00–2.75 mm; veins light yellow or light yellowish brown; membrane hyaline to slightly fumose; 14–18 dorsal and 12–16 anterior interfurcular costal setae with distal 0.3–0.5 of each row denser to large spinoid terminal seta; halter white; costal-vein ratio (section III/II) 0.60–0.73; M-vein ratio (inverse of M_{1+2} index of Deonier 1971) 0.60–0.70.

Abdomen: Terga, in posterodorsal view, semiglossy dark brown with sparse light-brown pruinosity; sides and venter same as terga; male with abdominal apex (dorsum

of epandrium) and margin of tergum 5 each bearing 2–3 pairs of macrochaetae as long as, but not as stout as, prescutellar macrochaeta. Male postabdomen: epandrium, in lateral view, slightly widest dorsally, bluntly rounded ventrally, with previously described macrochaetae dorsally and about 5 pairs of smaller setae posteroventrally; cercus about 0.8 of epandrium height, with numerous long marginal setulae and about 6 or more submarginal setulae including 3–4 projecting noticeably beyond posterior margin; surstylus, in lateral view, somewhat falciform, but with medially curving, long spicate process bearing ventral comb of 10 or more long, fine setulae; posterior edge of basal shaft of surstylus with comb of microsetulae; distal lobe of surstylus with dense covering of uniformly directed micropubesence, or microsetulae; surstylus, in ventral view, appearing as microsetulose dipperlike structure with long, tapering handle (pectiniform spicate process) curving posteromedial below cercus; pregonite short papilliform, bearing 2 long, apical setulae and located anterior to ventral lobe of epandrium; postgonite process, or complex (Deonier 1993; clasper of Rao and Mathis 1995), in lateral view, caligiform with long, ventromedially curved styliform lobe (postgonite, *sensu stricto*, Deonier 1971) bearing slightly distinguishable, rounded apical portion (uncus, Deonier 1971) and single preapical microsetula (entire styliform process projects nearly as far ventrad as surstylus); postgonite base complex composed of basal shaft with anterior microtubercle at midlength bearing usually 2 microsetulae and shoelike distal part bearing 6–8 longer, fine setulae on toe, or digit, and 6–8 microsetulae on remainder; phallopodeme moderately convex dorsally; aedeagus (phallus) short, broadly triangular, about as wide as long and with either a mucronate or inversely mucronate (indented) apex. Genital capsule formed above sternum 5; no sterna with central or medial membranous areas; sternum 5 about $1.7 \times$ as wide as 4. Female abdomen: cercus, in

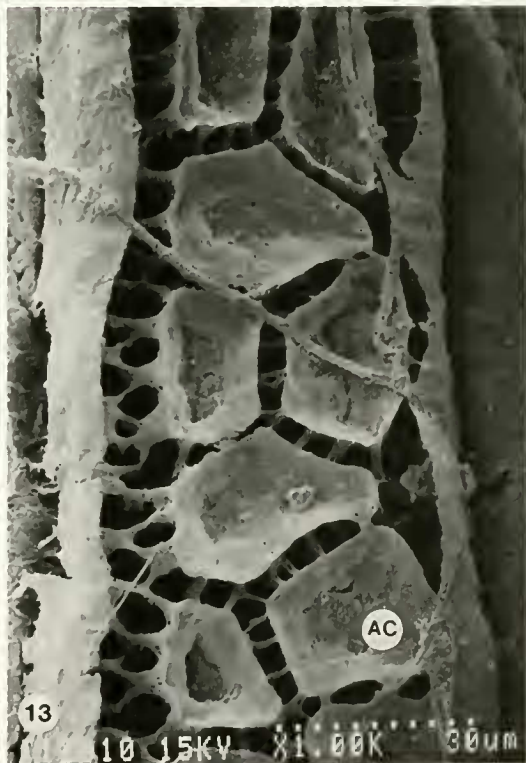
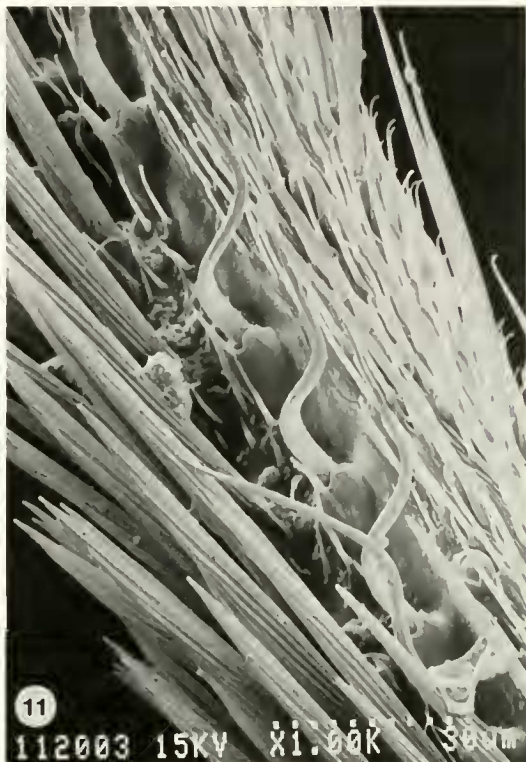
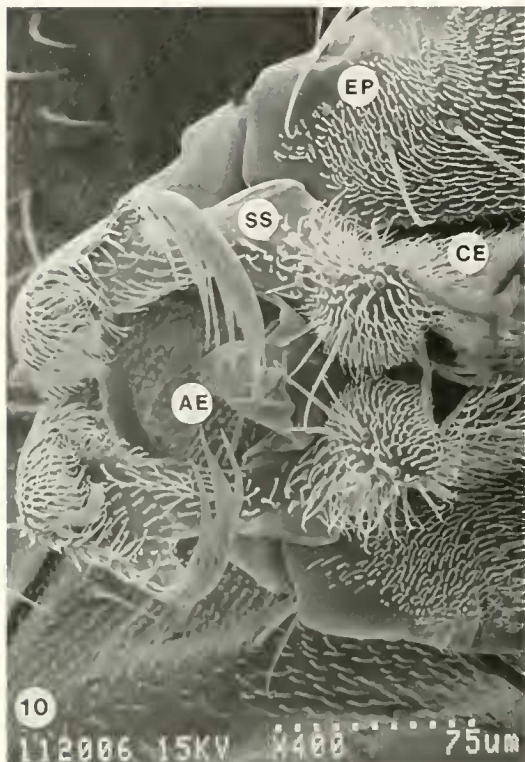
lateral view, obovoid, about $1.6 \times$ as long as wide (shorter than sternum and slightly longer than tergum 8) and with about 8 marginal setulae (longest subequal to cercal width) and 6–8 discal setulae (including 1–2 subequal in length to cercus); sternum 8, in lateral view, with 6–8 setulae projecting beyond margin and, in ventral view, with about 3 rows of setulae in addition to numerous rows of microsetulae (or micropubesence); sternum 8, in ventral view, with slightly concave posteromedial margin, about 0.8 as wide as sternum 5 and subequal to or slightly wider than other sterna. Ventral receptacle about as wide as deep (somewhat wider than cercus).

Etymology.—The specific epithet, *laffooni*, honors the late Dr. J. L. Laffoon (1922–1973), highly esteemed mentor and dipterist, in whose character were few inconsistencies. It was while on a museum and collecting tour of the northeastern United States in July 1961 with J. L. Laffoon that I first encountered *Rhysophora* (*R. robusta* Cresson) in a stand of *Pontederia cordata* L. in northern Ohio.

Holotype.—♂, USNM. Florida: Highlands Co: Lake Istokpoga, E. shore (VII-13-1990, D. L. Deonier, on *Pistia*).

Paratypes.—FLORIDA: Same data as holotype, 8 ♂, 2 ♀; Highlands Co: L. Istokpoga, E. shore (VII-13-1990, B. C. Deonier, on *Pistia*), 1 ♀; Highlands Co: L. Istokpoga, E. shore (VII-13-1990, M. Lillpop, on *Pistia*), 2 ♂, 1 ♀; Broward Co: USDA Aquatic Weed Lab. (VI-26-1995, D. L. Deonier, lab culture of *Pistia*) 1 ♂, 9 ♀; USDA Aquatic Weed Lab. (VI-26-1995, B. Maharajh), 1 ♂, 2 ♀; Davie, Ft. Laud. REC (13 Apr 1992, coll. B. Maharajh, reared from *Pistia stratiotes*), 5 ♂, 7 ♀; USDA Aquatic Weed Lab. (VI-26-1995, D. L. Deonier, dead from glove box 1, ex lab culture *Pistia*), 6 ♂, 6 ♀; 2d. Site, Finger Canal at 20-Mile Bend, Everglades Cons. Area 3 (VI-27-1995, D. L. Deonier, on *Pistia*), 20 ♂, 16 ♀; USDA Aquatic Weed Lab. (VI-30-1995, D. L. Deonier, dead in glove box 1, on *Pistia* [lab culture]), 7 ♂, 7 ♀;

USDA Aquatic Weed Lab. (VI-29-1995, B. Maharajh, on *Pistia*), 4 ♂, 3 ♀; USDA Aquatic Weed Lab. (VI-30-1995, D. L. Deonier, from glove box 1, ex lab culture *Pistia*), 1 ♀; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, laid eggs VI-30-VII-4-1995, D. L. Deonier, on *Pistia*), 1 ♂, 5 ♀; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, laid eggs VI-30-1995, 1 ♀ dead on VII-4-1995, D. L. Deonier, on *Pistia*), 1 ♂; USDA Aquatic Weed Lab. (adults coll: VI-30-1995, dead VII-3-1995; 4 + eggs laid and started, D. L. Deonier, on *Pistia*), 1 ♂, 1 ♀; USDA Aquatic Weed Lab. (coll: VI-30-1995, 1 adult dead VII-3-1995, laid 3 eggs, D. L. Deonier, on *Pistia*), 1 ♀; USDA Aquatic Weed Lab. (coll. & isol. from lab culture: VI-30-1995, FL-1 = ♀, FL-2 = ♂), 1 ♂, 1 ♀; USDA Aquatic Weed Lab. (adults coll. & isol: VI-30-1995, D. L. Deonier, on *Pistia*, 0 eggs), 16 ♂, 2 ♀; USDA Aquatic Weed Lab. (adults coll. & isol: VI-30-1995; 14 eggs laid; adults dead VII-3-1995, D. L. Deonier, on *Pistia*), 2 ♀; USDA Aquatic Weed Lab. (started VII-3-1995 from 1st instars from eggs laid by adults FL-1 & FL-2 isol. from lab culture VI-30-1995; 3d instars feeding saproph. VII-10-1995; pupar. VII-11; adults emerg: VII-18, D. L. Deonier) 2 ♂, 1 ♀; USDA Aquatic Weed Lab. (Pupar. coll: VI-26-1995, adult emerg: VI-28-1995, B. Maharajh), 1 ♂. Glades Co: Nicodemus Slough, St. Rte. 78 nr. L. Okeechobee (VI-30-1995, D. L. Deonier, on *Pistia*), 1 ♂, 2 ♀; Fisheating Cr. at US Highway 27 (VI-30-1995, D. L. Deonier, on *Pistia*), 5 ♂, 8 ♀. Martin Co: Site 2a (nr Okeechobee Levee) (VI-28-1995, D. L. Deonier, on *Pistia*), 6 ♂, 7 ♀; St. Lucie Canal, Port Mayaca (VI-28-1995, D. L. Deonier, on *Pistia*), 2 ♂, 4 ♀. Palm Beach Co: 2 mi. SE of South Bay (VI-27-1995, D. L. Deonier, on *Pistia*), 24 ♂, 22 ♀; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2: pupar. coll: VII-9; adult emerg: VII-10, D. L. Deonier, on *Pistia*). 1 ♂; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2:



pupar. VII-15; adult emerg: VII-21, D. L. Deonier, on *Pistia*), 1 ♀; W. Jupiter, nr. SW Fork of Loxahatchie R. (started VII-3-1995 from glove box 2; 3d instar VII-13; pupar. VII-14; adult emerg: VII-19, D. L. Deonier, on *Pistia*), 1 ♀; W. Jupiter, Perimeter Canal nr. SW Fork of Loxahatchie R. (VI-28-1995, D. L. Deonier, on *Pistia*, glove box 2), 13 ♂, 10 ♀; W. Jupiter, Perimeter Canal nr. SW Fork of Loxahatchie R. (VI-28-1995, D. L. Deonier, on *Pistia*, adults coll from rearing bag: VII-10), 1 ♂, 2 ♀. Polk Co: Tenoroc Fish Mgmt. Area (VII-17-1995, D. L. Deonier, on *Pistia*), 1 ♂, 11 ♀.

DESCRIPTION OF IMMATURE INSTARS

Egg (Figs. 12–13).—Length 0.47–0.64 mm (\bar{x} = 0.54); maximum width 0.13–0.20 mm (\bar{x} = 0.16). Newly laid egg nearly white, elliptical (except micropylar end more bluntly rounded), noticeably flattened ventrally, transversely convex dorsally; chorion microrugulose, or corrugate, except for ventral aeropyle strip bearing 1–2 irregular rows of irregularly shaped adhesion cups, or plates, on meshwork penetrating to undetermined extent into remainder of chorion. Micropylar process inconspicuous, including short stalk and slightly twisted conical cap, or tip. (Based on 17 specimens).

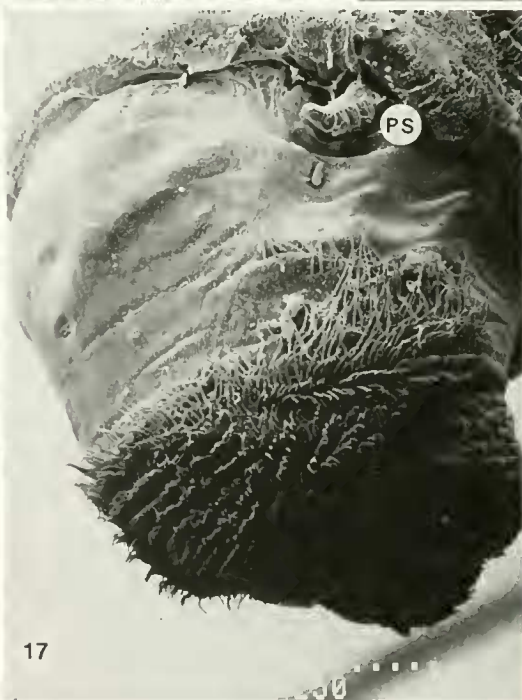
First-instar larva (Figs. 8, 14–15).—Length 0.68–0.85 mm (\bar{x} = 0.73) maximum width 0.13–0.17 mm (\bar{x} = 0.15). Body grayish white (integument semitransparent). Similar to third instar except in following characters: ends of body somewhat less tapering, spinulosity not as distinct; dorsolateral and lateral abdominal protuberances and ventral creeping welts not as distinct as in third instar; microspinular bands more numerous on most thoracic segments than in third instar, but spinular bands on ab-

dominal segments not as distinct. Antennae appearing 2-segmented with terminal segment ellipsoidal or long ovate, deeply constricted at joint, about $2.0 \times$ as long as wide and $2.0 \times$ as long as preceding segment. Subantennal sensory plate with 6–8 sensilla basiconica apparent. Head-lobe less distinctly bilobate, with feeding-comb microspinules of facial-mask usually with fewer and shorter teeth, sometimes with distal margin apparently only undulate or with 1 long, median tooth; some lateral microspinules with 8 teeth. Prothoracic (anterior) spiracles apparently nonfunctional, represented only by minute pit. Perianal pad swollen globosely and symmetrically on both sides of anus. Posterior tracheospiracular siphons shorter and more tapered than in third instar.

Cephalopharyngeal skeleton (Figs. 8, 14) length (excluding mouth-hook) 0.09 mm. Pharyngeal sclerite much paler than in third instar (only slightly sclerotized at cornual bifurcation and anteriorly into fused hypostomal sclerite); mouth-hooks apparently bifid on hook part (as seen in 1 specimen); mouth-hook mostly black with 1–2 pale spots in base part and with 1 ventrolateral tooth basally on hook part; hook and base parts subequal in length; base part apparently closely articulated (or fused) with dental and ligulate sclerites. Hypostomal and pharyngeal sclerites apparently fused; anterior ends of hypostomal sclerite articulated with upturned posterior ends of ligulate sclerites. Dorsal bridge of pharyngeal sclerites entirely hyaline, projecting somewhat acutely anteriorly over posterior part of hypostomal sclerite (Fig. 8); dorsal and ventral cornua apparently unforked posteriorly, hyaline and transparent; ventral cor-

←

Figs. 10–13. *Rhysophora laffooni*. 10, Male postabdomen, posteroventral view. 11, Male metabasitarsus (partial), ventral view showing part of row of ventral semihelicoid microsetulae. 12, Egg, ventrolateral view showing ventral aeropyle strip. 13, Egg, enlarged ventral view of adhesion cups on aeropyle meshwork. Abbreviations: AC = adhesion cups; AE = aedeagus; CE = cercus; EP = epandrium, MP = micropylar process (protuberance); SS = surstylus.



Figs. 14–17. *Rhyssophora laffoon*. 14, Head-lobe, first-instar larva, anterolateral view showing bifid mouth-hooks. 15, First-instar larva, posteroventral view of posterior tracheospiracular siphons (bases) and perianal pad. 16, Third-instar larva, lateral view showing head-lobe uppermost. 17, Third-instar larva, head-lobe and prothorax, dorsolateral view. Abbreviations: PA = perianal pad; PS = prothoracic spiracle; SA = subantennal sensory plate.

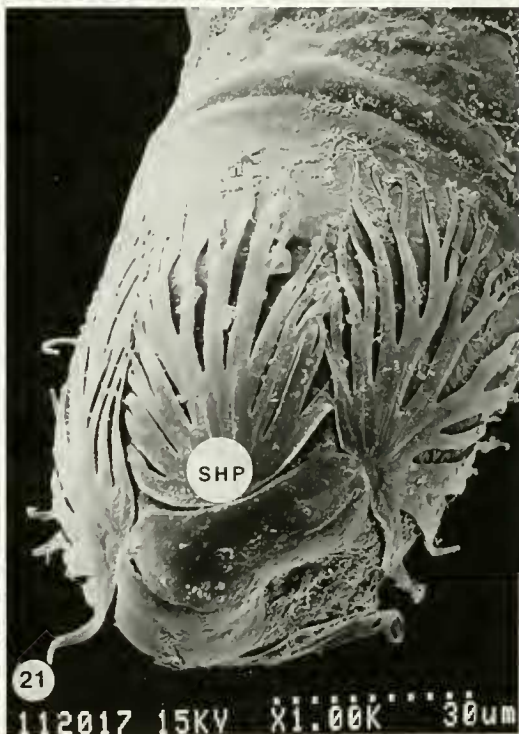
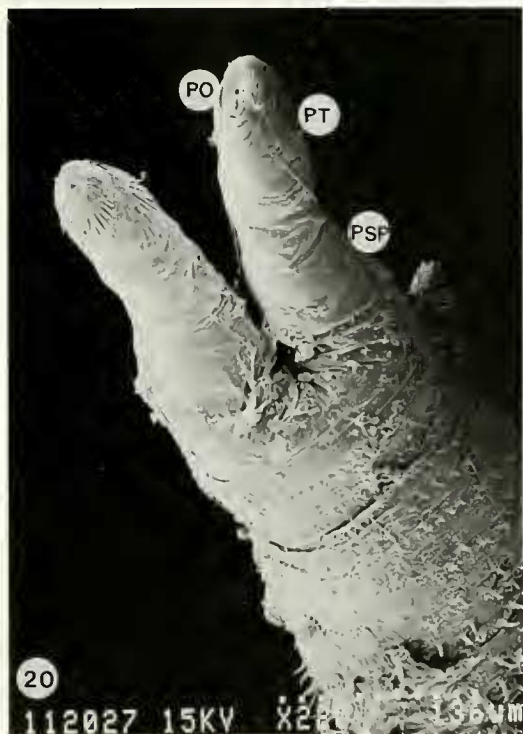
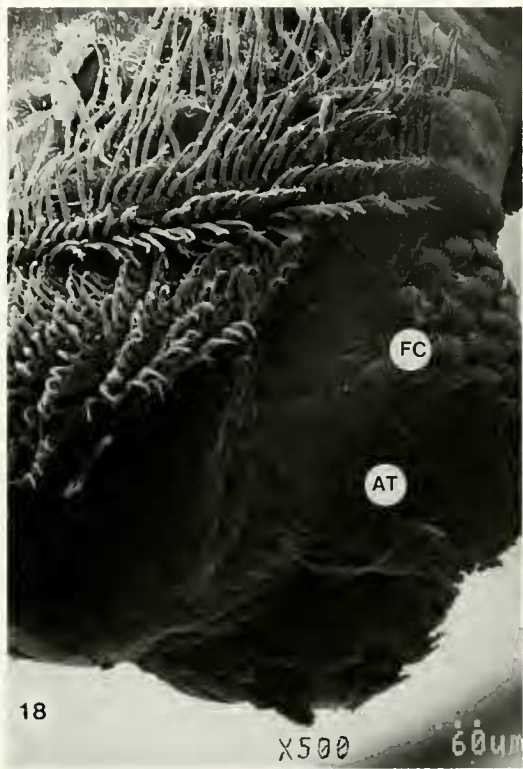
nu $2.0 \times$ as long as dorsal cornu. Ventral length of pharyngeal sclerite about $4.0 \times$ hypostomal length; ventral cornu about $2.5 \times$ hypostomal length. (Based on 4 specimens).

Second-instar larva (Fig. 27).—Length 2.5–2.9 mm ($\bar{x} = 2.7$); maximum width 0.44–0.47 mm ($\bar{x} = 0.45$). Body grayish white (integument semitransparent). Similar to third instar except in following characters: ends of body somewhat less tapering (difference in maximum prothoracic and maximum abdominal widths less and post-anal elongation only about 0.5 as long as in third-instar), spinulosity not quite as distinct; dorsolateral and lateral abdominal protuberances not as well developed or distinct; microspinular bands not as numerous as in third instar. Antennae 3-segmented, very similar to those of third instar except basal annular segment 1 only slightly wider than segment 2. Head-lobe distinctly bilobate, but flatter anteriorly and with fewer feeding-comb microspinules situated laterally and more anteriorly and ventrally.

Cephalopharyngeal skeleton similar to that of third-instar, but not measured or illustrated. (Based on 2 specimens).

Third-instar larva (Figs. 16–19, 24–26).—Length 4.36–4.85 mm ($\bar{x} = 4.68$); maximum width 0.58–0.68 mm ($\bar{x} = 0.61$). Body white or creamy white except very light-brown posterior spiracular peritremes, subfusiform, tapering gradually from abdominal segment 2 anteriorly to head-lobe and posteriorly from abdominal segment 6 to posterior tracheospiracular siphons. Head-lobe retractile, bilobate with each lobe, or half, bearing 3-segmented antenna distally and subantennal sensory plate anteroventrally; antennae only about 0.25 as long as mouth-hooks, segment 3 roundly pointed apically, about $2.0 \times$ as long as wide and nearly as long as 1 and 2 together; subantennal sensory plate of nearly same diameter as antennal segment 1. Each half of bilobate head-lobe covered (as part of so-called facial mask) laterally, ventrally, and anteriorly with 60+ feeding-comb micro-

spinules arranged in 10+ longitudinal rows; each comb, or pecten, widely spatulate and bearing 8–12 mostly uniordinal teeth distally about 0.3–0.5 as long as base; anterior part of facial mask with some microspinules bearing only 1–2 teeth and posterior microspinules in each row often with noticeably more sharply acute teeth; labium indistinct. Prothorax (segment 2 of some authors) with 14–16 mostly uniordinal bands (transverse rows) of pilose spinules on anterior 0.25–0.30, remainder posterior to prothoracic spiracle glabrous; prothoracic spiracle, in anterodorsal view, appearing like lamellate antenna (actually composed of apical polliciform, or thumblike, papilla and 3–4 short anterolateral papillae (on same side), each with fine median longitudinal line; meso- and metathorax each with about 8 bands of microspinules and about 6 bands of slightly larger spinules on anterior 0.3–0.5, followed by mostly glabrous posterior zone. Abdominal segments 1–7 each with numerous bands of microspinules and spinules, some small indistinct glabrous zones (usually near secondary furrows) dorsally and laterally, distinct ventrolateral spinulose protuberance at each end of ventral creeping welt, smaller lateral spinulose protuberances dorsal to and usually 1 anterior to and 1 posterior to larger ventrolateral protuberance; each creeping welt with 4+ bands of curved and slightly hooked types of spinules; 2 transverse secondary furrows (plicae) usually distinct dorsally and laterally on segments 3–6; each furrow separates zone of about 3 or 4 spinular bands each; abdominal segment 8 (anal segment of some authors) with 4 preanal and 6 post-anal bands of curved and slightly hooked spinules and, at most, only indistinct creeping welt. Perianal pad with nearly straight anterior and moderately convex, or arched, posterior margin and about as wide as segment 8 (sometimes appearing wider and extending onto sides of segment); posterior limit of segment 8 usually marked by 1 or 2 pairs of ventrolateral postanal tubercles (some of which bear terminal furcate struc-



ture, or rayed sensilla of some authors). Postanal elongation (respiratory, or breathing, tube of some authors) of abdominal segment 8 subequal in length to mesothorax, tapering slightly to posterior tracheospiracular siphons; postanal elongation partially retractile, and glabrous except for 2 basal spinular bands. Posterior tracheospiracular siphons glabrous, partially retractile; posterior spiracular peritreme light brown, roundly pointed apically, about $1.4 \times$ as long as greatest diameter, $0.4\text{--}0.5$ length of entire siphon, and with medioapical orifice surrounded by 4 symmetrically arranged, dendroid spiracular hydrofuge processes.

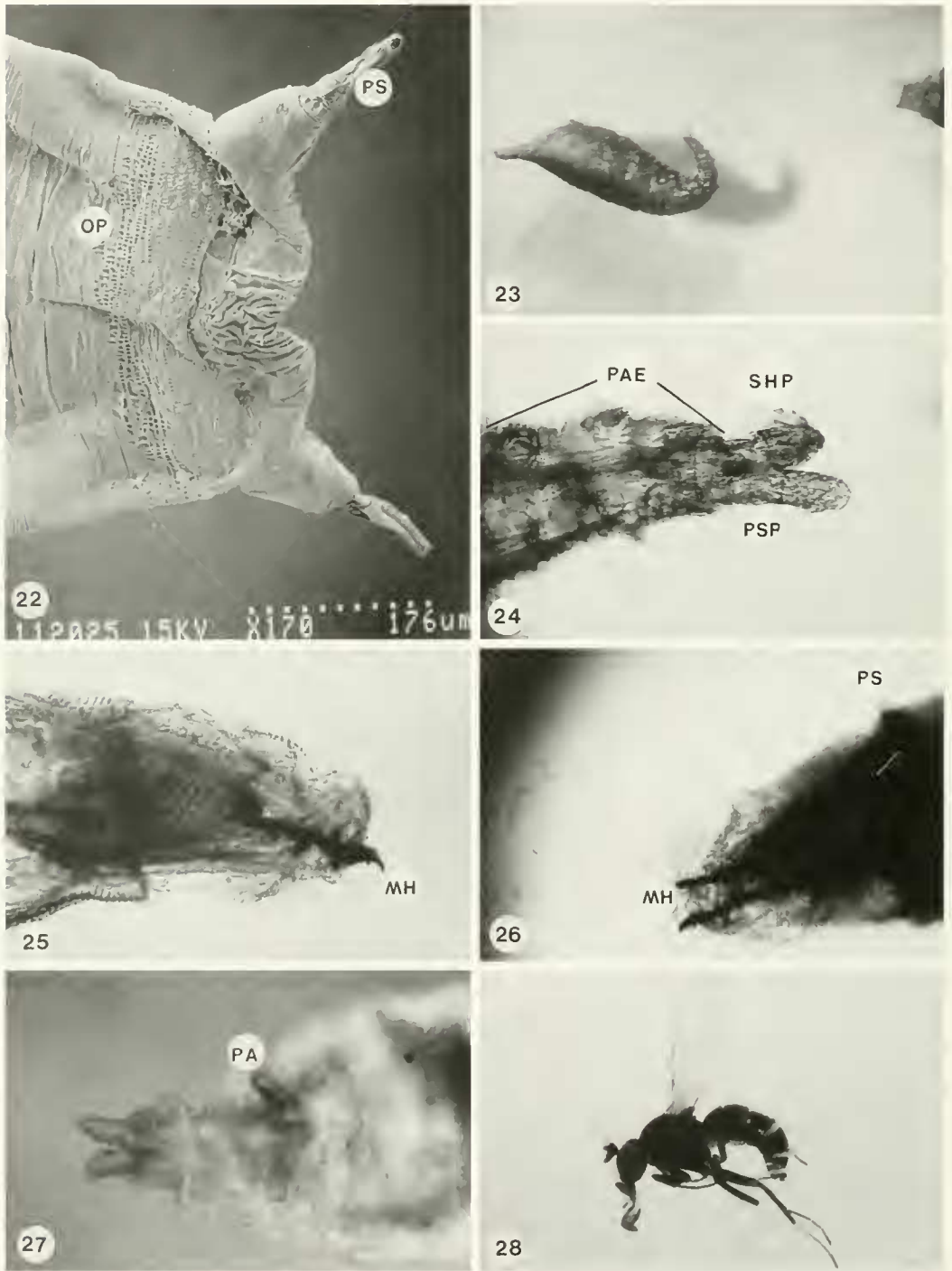
Cephalopharyngeal skeleton (Figs. 9, 25–26) length $0.43\text{--}0.56$ mm (excluding mouth-hook). Pharyngeal sclerite dark brown or black centrally at cornual bifurcation, remainder appearing fiber-streaked hyaline, and lightly sclerotized. Mouth-hooks paired, slightly shorter than hypostomal sclerite, with single tooth near midlength, separate basally but apparently fused with basally situated, paired dental sclerites; hook part of mouth-hook black, falciform (smoothly curved and toothless distad of midlength tooth); dental sclerite appearing microfenestrate and articulating closely (or fused) with ventral projection of mouth-hook base; posterodorsal projection of mouth-hook base articulating with anterior arm of hypostomal sclerite. Hypostomal sclerite, in ventral view, with hypostomal bridge hyaline except for dark, narrow posterior margin; posterior arms of hypostomal sclerite acutangular at tips articulating with pharyngeal sclerites; epistomal sclerite apparently articulated closely (or fused) with upper edge of posterodorsal projection of mouth-hook base. Hy-

postomal and pharyngeal sclerites not fused; dorsal bridge of pharyngeal sclerites, in lateral view, angled at about 45° from horizontal and hyaline except for narrow, heavily sclerotized black strip through middle; dorsal cornu of pharyngeal sclerite ending posteriorly in roundly pointed, digitiform lobe preceded by noticeable expansion; ventral cornu $1.4\text{--}1.8 \times$ as long as dorsal cornu, projecting into metathorax, widest posteriorly ($2.5\text{--}3.0 \times$ dorsal cornu width), and with dorsal margin bearing sclerotized tubercle, or toothlike lobe, near cornual bifurcation; distal, or posterior 0.5 or more of ventral cornu mostly hyaline and somewhat fiber-streaked; cibarial (pharyngeal) grooves visible in ventral view. Ventral length of pharyngeal sclerite $3.8\text{--}4.2 \times$ hypostomal length; ventral cornu length $2.3\text{--}2.7 \times$ hypostomal length. (Based on 4 specimens).

Puparium (Figs. 20–23).—Length $3.10\text{--}4\text{--}27$ mm ($\bar{x} = 3.69$); maximum width $0.87\text{--}1.06$ mm ($\bar{x} = 0.95$). Empty puparium opaque, moderate to dark brown, scaphiform, sometimes subfusiform, with ventral surface slightly flatter than most of dorsum, and with posterior tracheospiracular siphons and often posterior $0.25\text{--}0.30$ of body curved steeply dorsad or dorsoanteriorly. Prothoracic (anterior) spiracles on prominent respiratory horns borne anterolaterally on dorsocephalic cap (operculum), with single dorsoapical spiracular orifice; dorsocephalic cap with mostly truncated, medially notched anterior and slightly undulate or arched posterior margin; anterior 0.15 of dorsocephalic cap with about 6 interrupted bands of microspinules preceding 3–4 bands of larger spinules, remainder glabrous except for posterior spinulose zone;

←

Figs. 18–21. *Rhysophora laffooni*. 18, Head-lobe, third-instar larva, anterolateral view ($500\times$). 19, Head-lobe, third-instar larva, enlarged lateral view showing feeding-comb microspinulae. 20, Puparium, dorsolateral view showing posterior tracheospiracular siphons and postanal extension. 21, Postspiracular peritreme of puparium, left posterodorsolateral view. Abbreviations: AT = antenna; FC = feeding-comb microspinulae; PO = spiracular (peritreme) orifice; PSP = posterior tracheospiracular siphon; PT = posterior spiracular peritreme; SHP = spiracular hydrofuge process.



Figs. 22–28. *Rhyssophora laffooni*. 22, Puparium, prothorax and mesothorax, dorsal view showing part of dorsocephalic cap (operculum) and prothoracic respiratory horns. 23, Puparia, left lateral and dorsal views (taken at 10 \times). 24, Third-instar larva, posterior end, ventrolateral view (taken at 100 \times). 25, Third-instar larva, anterior end, lateral view showing mouth-hooks (taken at 100 \times). 26, Third-instar larva, anterior end, ventral view (taken

cap with numerous microfolds (microplicae). Puparium with only slightly elevated or no protuberances and with numerous bands of microspinules and spinules between dorsocephalic cap and postanal elongation. Perianal pad indistinct; abdominal segment 8 with 8–10 spinular bands consisting of both curved and hooked types of spinules; postanal elongation glabrous except for 2 basal spinular bands; posterior spiracular peritreme rounded apically, about $1.4 \times$ as long as greatest diameter and $0.4\text{--}0.5$ length of entire siphon and with medioapical spiracular orifice equipped with hydrofuge processes as in third instar larva; spiracular remnant (scar) not apparent. (Based on 15 specimens).

Specimens examined.—Broward Co: USDA Aquatic Weed Lab. (started VII-3-1995 from 1st-instar larvae from eggs laid by adults FL-1 & FL-2 isol. from lab *Pistia* culture VI-30-1995; 3d-instar larvae feeding saproph. VII-10-1995; pupar. VII-11; adults emerg: VII-18, D. L. Deonier), 3 puparia; USDA Aquatic Weed Lab. (adults coll. ex Greenhouse *Pistia* culture, ovip: VI-30-1995, D. L. Deonier) 9 eggs (1 full), 4 1st-instar larvae and 2 2d-instar larvae; USDA Aquatic Weed Lab. (pupar. coll: VI-26-1995 ex Greenhouse *Pistia* culture, adult emerg: VI-28-1995, B. Maharajh), 1 puparium; (VII-6-1995, B. Maharajh, ex Greenhouse *Pistia* culture), 19 puparia (empty and full); Martin Co: Site 2a (nr Okeechobee Levee) (VI-28-1995, D. L. Deonier, 3 early 3d-instar larvae isol. VII-12, pupar. VII-14-1995, on *Pistia*), 2 3d-instar larvae + 1 puparium; (VI-28-1995, D. L. Deonier, puparium VII-10–11-1995, on *Pistia*), 1 early puparium; Palm Beach Co: Perimeter Canal nr SW Fork of Loxahatchie R., W. Jupiter (VI-28-1995, D. L. Deonier, on *Pis-*

tia), from 13 ♂, 10 ♀ (isol-in plastic vials with 1+ male); 34 eggs laid VI-29–30-1995 from which were preserved 6 1st-instar larvae, 4 3d-instar larvae, and 7 puparia; unspecified (VI-28–VII-15-1995, D. L. Deonier, on *Pistia*), 1 puparium.

LIFE HISTORY AND ECOLOGY

Adult.—The adults of *Rhysophora laffooni* are small, black flies, which in sufficient numbers are conspicuous on the leaves of *Pistia*. They have a patchlike distribution in areas of *Pistia* concentration, with occasional high density locally (estimated 1 adult per plant in one 5 m^2 area). Whether this patchy within-habitat distribution is correlated with infestations of larval *Spodoptera* (Lepidoptera: Noctuidae) has not been determined. Also, the existence of aggregation pheromones, as in *Rhysophora robusta* Cresson (unpublished experimental data), is a possibility. Close observations of feeding in the laboratory and in the field indicate that the adults feed on microbes (and perhaps some plant cells) on the decaying, damaged edges of *Pistia* leaves, especially ones fed upon by *Spodoptera* caterpillars. This contrasts with the nectar feeding observed in adults of *R. robusta*.

Courtship and copulation were not observed. Females oviposited only on *Pistia* leaves (sometimes on both surfaces, in the laboratory) and mostly centrally and basally on the adaxial surface. The females moved slowly and intermittently over the *Pistia* plants while they laid eggs singly or in scattered groups (seldom of sufficiently close spacing to constitute an egg mass). Although maximum number of eggs per female was not measured, one female laid 16 eggs in one day. Adults appear to spend

←

at $100\times$). 27, Second-instar larva, posterior end, ventral view (taken at $100\times$). 28, Adult male, left lateral view (taken at $12.5\times$). Abbreviations: MH = mouth-hook(s); OP = operculum (dorsocephalic cap); PA = perianal pad; PAE = postanal extension; PS = prothoracic respiratory horn or prothoracic spiracle; PSP = posterior tracheospiracular siphon; SHP = spiracular hydrofuge process.

much of the daylight period resting in shaded areas where leaves of adjacent plants overlap. In one observation made on about 30 adults in a glove box with a red light at 11:00 p.m., most had their wings elevated (as was first observed in *Hydrellia discursa* Deonier by Deonier, in press).

Egg.—The incubation period ranged from 1 to 3 days for 14 eggs at 18–24°C. On one occasion eggs laid within the previous 2-hour period could be readily moved with a needle probe, but older eggs adhered to the leaf. It is possible that the adhesion cups in the ventral aeropyle strip are coated with an adhesive at oviposition which requires some time to dry. Applying interpretations from Hinton (1981 and earlier), the ventral aeropyle strip facilitates air entrapment and thus automatic plastron formation during inundation of the ovisite or simply when droplets of water cover the egg.

Larva.—The stadia were not measured. The time required from oviposition to adult emergence was 17 and 18 days for 2 specimens; egg eclosion (hatching) to adult emergence was 8, 12, and 16 days for 3 specimens; and eclosion to pupariation was 9 and 11 days for 2 specimens. Search of over 100 *Pistia* plants from the field and laboratory, or greenhouse, cultures did not reveal any mining larvae. However, observation of second- and third-instar larvae reared in the laboratory showed them feeding on microbial material in decayed tissue, especially at the base of the rosette. Guts packed throughout with black material were observed in several second- and third-instar larvae. Since the larvae, especially the second- and third-instar like those of *Notiphila aenigma* Cresson, *N. carinata* Loew, *N. solita* Walker, *N. (Dichaeta) caudata* Fallén, and *Cirrula austrina* (Coquillett) [as illustrated and described by Busaca and Foote (1978), Deonier et al. (1979), Eastin and Foote (1971), and Simpson (1979)] all have comblike components in the facial mask, it seems very probable that all are microphagous filter-feeders and that microbes and other particles are collected by the feeding-

comb (pecten) microspinules and transferred into the cibarium during the rapid partial head-lobe involution and retraction. The mouth-hooks retain their primary locomotory function and possibly work in an ancillary way by breaking loose microbes and particles from clumps, or aggregations. Although they did not illustrate the facial mask, it seems appropriate to point out that Steinly and Runyan (1979) observed that the larvae of *Leptopsilopa atrimana* (Loew), another member of the subfamily Discomyzinae, ingested decay microbes from grass clippings and had guts packed with black material.

The role of any specific microsaprophyagy in the overall specific association of this fly species with *Pistia* is yet to be determined by a few laboratory feeding experiments.

Puparium.—The time from pupariation to adult emergence was measured as 5, 6, and 7 days for 3 specimens. Although most puparia were found in the air cavities in leaves damaged by *Spodoptera* larvae, this species sometimes uses undamaged leaves for pupariation, as evidenced by the discovery of adult flies in 2 of 5 *Pistia* cultures collected 3 days previously and held in screened tanks. All leaves therein appeared healthy.

The posterior spiracular peritremes are rounded, not pointed apically and are, along with the remainder of both posterior tracheospiracular siphons, upturned and often curled anteriorly. Puparia occasionally found on the undamaged leaf surface are fairly readily moved and, therefore, any stability gained is probably via cuticular spinules interlacing with the velvety leaf pubescence.

ACKNOWLEDGMENTS

Acknowledgement is made for facility support to the USDA Aquatic Weed Laboratory under the leadership of Dr. T. Center and to the Department of Entomology/Nematology, University of Florida. Special acknowledgement is made to Mr. William Carpenter, Department of Entomology/Nematology, for his enthusiastic assistance

in scanning electron microscopy and to Mr. Wiley Durden and Mr. B. (Vinda) Maharajh, USDA Aquatic Weed Laboratory, for their assistance in collecting. Ms. Ceci Humphreys-Vivas and Mr. Juan Villanueva-Jiménez performed the task of processing the manuscript onto computer diskette.

LITERATURE CITED

- Busaca, J. D. and B. A. Foote. 1978. Biology and immature stages of two species of *Notiphila*, with notes on other shore flies occurring in cattail marshes (Diptera: Ephydriidae). *Annals of the Entomological Society of America* 71(3): 457-466.
- Cresson, E. T., Jr. 1924. Descriptions of new genera and species of the dipterous family Ephydriidae. Paper VI. *Entomological News* 35(5): 159-164.
- . 1942. Synopses of North American Ephydriidae (Diptera). I. The subfamily Psilopinae, with descriptions of new species. *Transactions of the American Entomological Society* 68: 101-128.
- . 1946. A systematic annotated arrangement of the genera and species of the Neotropical Ephydriidae (Diptera). I. The subfamily Psilopinae. *Transactions of the American Entomological Society* 71: 129-163.
- Deonier, D. L. 1971. A systematic and ecological study of Nearctic *Hydrellia* (Diptera: Ephydriidae). *Smithsonian Contributions to Zoology* 68: 1-147.
- . 1993. A critical taxonomic analysis of the *Hydrellia pakistanae* species group (Diptera: Ephydriidae). *Insecta Mundi* 7(3): 133-158.
- . In press. Mechanisms of competitive coexistence in the sibling species, *Hydrellia bilobifera* Cresson and *discursa* Deonier (Diptera: Ephydriidae). *Acta Zoologica Academiae Scientiarum Hungaricae*.
- Deonier, D. L., W. N. Mathis, and J. T. Regensburg. 1979. Natural history and life-cycle stages of *Notiphila carinata* (Diptera: Ephydriidae). *Proceedings of the Biological Society of Washington* 91(4): 798-814.
- Eastin, W. C. and B. A. Foote. 1971. Biology and immature stages of *Dichaeta caudata* (Diptera: Ephydriidae). *Annals of the Entomological Society of America* 64(1): 271-279.
- Hinton, H. E. 1981. Biology of Insect Eggs, in Three Volumes, Vol. II. pp. i-xviii, 475-778. Pergamon Press, New York.
- Mathis, W. N. 1977. A revision of the genus *Rhysophora* Cresson with a key to related genera (Diptera: Ephydriidae). *Proceedings of the Biological Society of Washington* 90(4): 921-945.
- Mathis, W. N. and T. Zatwarnicki. 1995. World catalog of shore flies (Diptera: Ephydriidae). *Memoirs on Entomology, International* 4: 1-423.
- McAlpine, J. F. 1981. Morphology and terminology—Adults, pp. 9-63. *In* McAlpine, J. F., et al., eds., *Manual of Nearctic Diptera*, Vol. 1. vi + 674 pages [Vol. 1 = Monograph 27 of Research Branch, Agriculture Canada]. Ottawa.
- Osten Sacken, C. R. 1881. An essay on comparative chaetotaxy, or the arrangement of characteristic bristles of Diptera. *Mittheilungen des Münchener Entomologischen Vereins*, 5: 121-138.
- Rao, N. and W. N. Mathis. 1995. A revision of the genus *Rhysophora* Cresson (Diptera: Ephydriidae). *Proceedings of the Entomological Society of Washington* 97(3): 666-688.
- Simpson, K. W. 1979. Evolution of life histories in the Ephydrini. Pages 99-109. *In* Deonier, D. L., ed. *First Symposium on the Systematics and Ecology of Ephydriidae* (Diptera). iii + 147 pages. North American Benthological Society, Oxford, Ohio.
- Steinly, B. A. and J. T. Runyan. 1979. The life history of *Leptopsilopa atrimana* (Diptera: Ephydriidae), pp. 139-147. *In* Deonier, D. L., ed., *First Symposium on the Systematics and Ecology of Ephydriidae* (Diptera). iii + 147 pp. North American Benthological Society, Oxford, Ohio.